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Integrating Solid State Detector With Segmentation For Scanning Transmission Soft X-ray Microscopy

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Beamline(s): X1A

Introduction: An integrating solid state detector with segmentation has been developed that addresses the needs in scanning transmission x-ray microscopy (STXM) below 1 keV photon energy. In STXM a Fresnel zone plate is used to focus monochromatic x-rays to a diffraction limited spot. A sample is raster scanned through the focus and a detector measures the transmitted x-ray flux with a pixel dwell time in the order of milliseconds. For a good signal to noise measurement, the detector has to be highly efficient and exhibit low intrinsic noise. Traditionally counting detectors like gas flow proportional counters or photomultiplier tubes coupled to fluorescent screens have been used in STXM. Counting detectors have a limited photon count rate capability and the sensitive area can not easily be subdivided into several independent segments. In STXM a segmented detector with appropriate geometry can be used to get additional information other than absorption contrast from the sample. A quadrant arrangement can be used for differential phase contrast imaging and an annular segment can be used for dark field imaging. For the integrating solid state detector an uncooled silicon chip [1] with segmented p/n junctions is used for the conversion of x-rays to electric charge. Eight independent low noise analog readout channels amplify and integrate the x-ray signal for each pixel.

Results: The integrating solid state detector with segmentation (**Figure 1**) has been tested successfully on beamline X1-A at the NSLS, and now it is installed permanently on the room temperature scanning transmission x-ray microscope at the inboard branch of the X1-A beamline, which operates at the Oxygen K-edge. The measured rms noise for absorption contrast has been measured to be 8 photons per integration cycle. The photon collection efficiency for 520 eV x-ray photons has been measured to be 94 %.

Conclusions: The integrating silicon detector with segmentation compliments the improvements of scanning transmission x-ray microscopy at the NSLS. In addition to the improvements in efficiency and rate capability, new imaging modes like differential phase contrast or dark field imaging are explored using the segmentation.

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References:

1. J. Kemmer, “Fabrication of low noise silicon radiation detectors by the planar process”, Nuclear Instruments and Methods, **A 169**, pp. 499-502, 1980

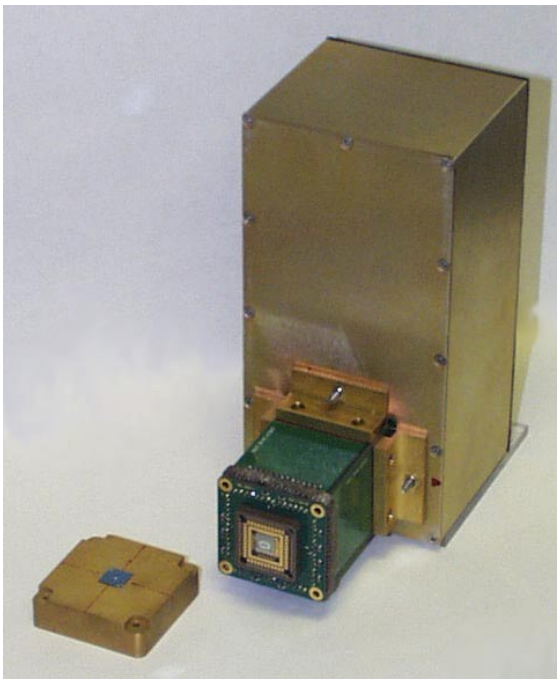

Figure 1: Photograph of the detector assembly.